PTO-08-2566

CC = JP
19821116
Kokai
57186378

LASER DEVICE
[Re-za souchi]

Yoshihide Kanehara

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. FEBRUARY 2008
TRANSLATED BY: THE MCELROY TRANSLATION COMPANY

PUBLICATION COUNTRY	(19):	JP
DOCUMENT NUMBER	(11):	57186378
DOCUMENT KIND	(12):	Kokai
PUBLICATION DATE	(43):	19821116
APPLICATION NUMBER	(21):	56070522
APPLICATION DATE	(22):	19810511
INTERNATIONAL CLASSIFICATION[3]	(51):	H 01 S 3/097
		3/10
INVENTOR	(72):	Yoshihide Kanehara
APPLICANT	(71):	Mitsubishi Electric Corporation
TITLE	(54):	LASER DEVICE
FOREIGN TITLE	[54A]:	Re-za souchi

Claims

1. A laser device comprising a sealed container; a pair of opposing electrodes arranged within the aforementioned container with a lasing medium arranged there between; a power source that supplies pulse energy to the aforementioned pair of electrodes to excite the lasing medium; and a pulse count control circuit that counts the number of pulses output from the aforementioned power source.

2. The laser device recorded in Claim 1, characterized in that the frequency of the output pulses controlled by the pulse count control circuit is higher than the frequency of the laser output.

3. The laser device recorded in Claim 1 or Claim 2, characterized in that a rate multiplier is used as the pulse count control circuit.

Detailed explanation of the invention

The present invention pertains to a laser device; in particular, it pertains to a laser device with improved control of the energy that excites the lasing medium.

A conventional carbon dioxide gas laser device is shown in Figure 1. In Figure 1, a sealed container (1) is filled with a lasing medium gas (2), and when discharge power is supplied from a power source (4) to a pair of electrodes (3A), (3B) arranged inside sealed container (1) a discharge (5) is generated, exciting lasing medium gas (2). Laser oscillations occur between a total reflection mirror (6) and a partially transparent mirror (7), and laser output (8) is transmitted to the outside.

The discharge power output by power source (4) of this type of conventional device is shown in Figure 2(a); the horizontal axis indicates time (t). The output frequency of the discharge power shown in Figure 2(a) is higher than the frequency of the laser output, for example, on the order of 100 kHz, with an output waveform that is pulse-width controlled. As shown in Figure 2(b), the average value of the discharge power varies in proportion to the pulse width. When the pulse width is controlled in this

manner, the laser output (11) appears as shown in Figure 3. In Figure 3, the horizontal axis indicates the average value of the discharge power, and the vertical axis (9) indicates the magnitude of laser output (8).

When the pulse width is controlled in this manner, the laser output characteristic (11) is zero where the discharge power is low; in other words, a dead band (12) appears.

This is because it is necessary to supply excitation power of a certain level or higher to laser medium (2) in order to perform laser oscillation.

The conventional laser device is constructed as described above; however, there is the problem that the output characteristic (11) is not entirely proportional to the discharge power, and a dead band (12) appears, so that it is extremely difficult to control the discharge power whereby laser output (8) is output in proportion to the laser output command value.

The present invention was devised for the purpose of eliminating the problem of the aforementioned prior art; its purpose is to provide a laser device that can control the laser output by controlling the pulse count, so that the laser output is proportional to the pulse count per unit time and no dead band appears.

In the following, application examples of the present invention will be explained with reference to the figures.

Figure 4(c), (d), and Figure 5 illustrate the principle of the present invention. The discharge power output by power source (4) is shown in Figure 4(c); the horizontal axis indicates time (t). The pulse waveform shown in Figure 4(c) is a pulse count controlled waveform having portions where the pulse count of the pulsed discharge power is less dense and portions where it is more dense. In addition, Figure 4(d) represents the average value of the pulse count controlled discharge power shown in Figure 4(c). When the discharge power is pulse count controlled, each pulse of the discharge power is made uniform, so that the output characteristic (13) appears as shown in Figure 5. In Figure 5, the

horizontal axis represents the average value of the discharge power and the vertical axis (a [sic; 9]) indicates the magnitude of laser output (8). The laser output characteristic (13) is proportional to the average value of the discharge power, i.e., the pulse count per unit time of the discharge power.

Moreover, with such a control method, the dead band will be eliminated.

Accordingly, by providing a pulse count command value to power source (4), the laser output becomes proportional to the pulse count command value.

An application example for the implementation of this principle is explained with reference to Figure 6. In Figure 6, (14) is a device such as a pulse count control device or a computer that outputs a digital output. Note that it also can be a device constructed from an analog adder circuit, with that output A/D converted and then output. The output from this device (14) is input to a rate multiplier (15) as a digital command value. This rate multiplier (15) converts a pulse train output from pulse generator (16) into a digital train that is proportional to the digital command value and outputs this pulse train to power source (4).

Here, if the digital command value is X, the maximum digital command value is X_{MAX}, and the count per unit time of the pulse train output from pulse generator (16) is a, then the count (Y) per unit time of the pulse train output from rate multiplier (15) will be as expressed by Equation (I) below.

$$Y = \frac{a}{X_{MAX}} \cdot X \qquad \cdots\cdots (I)$$

Figure 7 represents this characteristic as a timing diagram. Figure 7(a) is the pulse train (a) output from pulse generator (16); this value can selected to be higher than the laser output frequency, for example, a value of 100 kHz or more. Figure 7(b) is digital the command value (x), and Figure 7(c) is the output of rate multiplier (15). In other words, to output a pulse train that is proportional to the digital

command value (x), rate multiplier (15) operates to make the pulse train output from pulse generator (16) appear as a toothless waveform. Note that the pulse width of each pulse is identical to the pulse width of the pulse train output from pulse generator (16). When the output pulse train (y) from rate multiplier (15) is thus input to power source (4), power source (4) supplies discharge power to electrodes (3A), (3B) according to pulse train (y), generating discharge (5). In this case, the discharge power of each pulse is identical, and if that value is W_p, the discharge power W_D supplied to electrodes (3A), (3B) per unit time by power source (4) will be as expressed by Equation (II) below.

$$W_D = W_p \cdot Y = \frac{n \cdot W_p}{X_{MAX}} \cdot X \quad \cdots\cdots \text{(II)}$$

Moreover, if the laser output (8) with respect to one pulse is Q_p, the laser output Q_D per unit time will be as expressed by Equation (III) below.

$$Q_D = Q_p \cdot Y = \frac{n \cdot Q_p}{X_{MAX}} \cdot X \quad \cdots\cdots \text{(III)}$$

Equation (III) shows that the pulse output Q_D per unit time is proportional to the digital command value (x).

Figure 8 illustrates another application example of the present invention, a silent discharge type carbon dioxide gas laser where electrodes (17A), (17B) are [illegible] covered by an insulating material. With this application example, the waveform of the pulse count-controlled output current from power source (4) appears as shown in Figure 9(a). Note that a silent discharge type carbon dioxide gas laser device typically is controlled with alternating current, so that alternating positive and negative pulses are

output. Figure 9(b) represents the discharge power; it is positive even when the output current in Figure 9(a) is negative, a silent discharge (18) is generated, and laser oscillations occur.

Thus, even with a silent discharge type carbon dioxide gas laser device, the effect will be identical to that for the aforementioned application example shown in Figure (6).

As described above, the present invention has the effect that the output of a laser can be controlled by controlling the pulse count; therefore, a laser device for which the laser output per unit of time is proportional to the pulse count, with no dead bands, can be realized, and because the laser output is controlled by a device such as a numerical controller or a computer, it exhibits an extremely good control characteristic. Moreover, the pulse count or the digital command value is proportional to the laser output, without detection and control of the laser output; therefore, open loop control is possible, simplifying the device configuration and a high-speed, high-response laser output can be obtained.

Brief description of the figures

Figure 1 is a diagram illustrating one example of a conventional carbon dioxide gas laser device.

Figure 2 is a timing diagram for the purpose of explaining the operation of a conventional carbon dioxide gas laser device.

Figure 3 is a graph of the laser output characteristic of the conventional carbon dioxide gas laser device.

Figure 4 is a timing diagram for the purpose of explaining the laser device of the present invention.

Figure 5 is a graph of the laser output characteristic of the laser of the present invention.

Figure 6 is a diagram illustrating a laser device according to an application example of the present invention.

Figure 7 is a timing diagram for the purpose of explaining the operation in Figure 6.

Figure 8 is a diagram illustrating another application example of the present invention.

Figure 9 is timing diagram for the purpose of explaining the operation in Figure 8.

Explanation of symbols

1 Container

2 Laser medium gas

3A, 3B Electrodes

4 Power source

5 Discharge

6 Fully reflective mirror

7 Partially translucent mirror

8 Laser output

9 Laser output strength

10 Average value of discharge power

11 Laser output characteristic

12 Dead band

13 Laser output characteristic

14 Computer or numerical control device

15 Rate multiplier

16 Pulse generator

17A, 17B Electrodes

18 Silent discharge

Note that the in the figures, identical reference numbers designate identical or corresponding components.

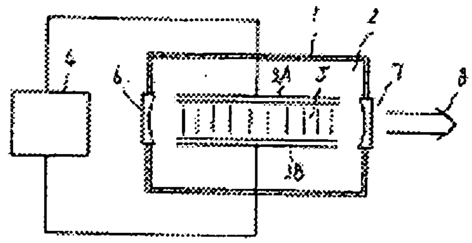

Figure 1

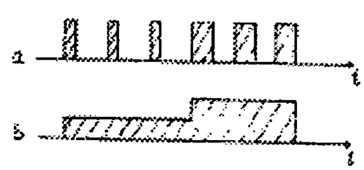

Figure 2

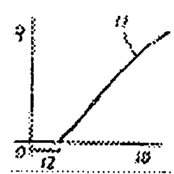

Figure 3

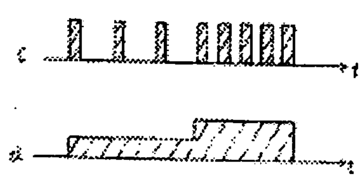

Figure 4

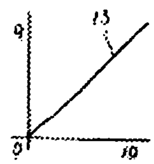

Figure 5

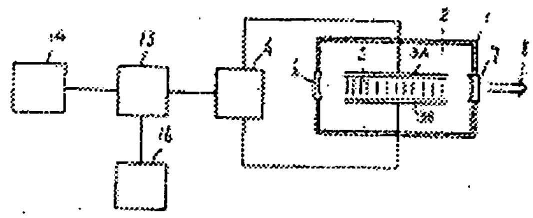

Figure 6

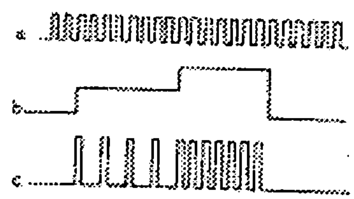

Figure 7

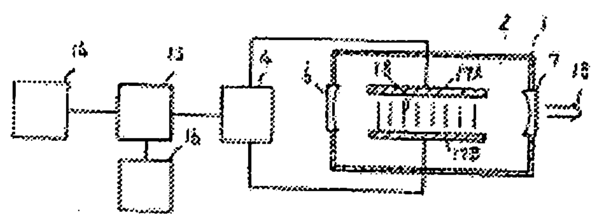

Figure 8

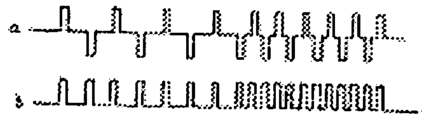

Figure 9